XRCT-Net: Development of a Novel Sparse View Deep Learning Framework for Safer, Cheaper, and More Accessible CT Imaging

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Computed tomography (CT) is an extensively used imaging technology that stacks hundreds of x-ray radiographs captured around a patient to generate detailed physiological images for various clinical procedures. However, CT scans pose several limitations, exposing patients to 8 years' worth of background radiation dosage (7 mSv) and costing nearly 10 times as much as standalone x-rays, leading to reduced availability in developing regions. To address these drawbacks, I developed a machine learning framework for reconstructing CT volumes solely from one or two x-rays. Since existing x-ray/CT datasets are small and contain pose-based discrepancies, I simulated x-ray beam dynamics on volumes from public CT datasets to synthesize training data. Two neural networks for CT reconstruction, featuring one and two inputs respectively, were iteratively engineered before final network architectures were tested and trained for 20 hours. The final neural networks were able to generate three-dimensional CT scans with accuracies ranging from 93% to 97% with only one or two x-rays, on par or exceeding accuracies of current state-of-the-art methods. Through additional validation on computationally replicated clinical procedures, CT scans generated from the neural networks are found to be viable for important clinical applications such as bronchial surgery planning and dose modulation. Finally, the developed neural networks are deployed on a cloud-computing-powered hardware prototype for low-cost, rapid, and remotely accessible CT imaging. This framework may reduce CT radiation exposure by 93% and imaging costs by 80%. Additionally, the hardware system is integrable with standalone x-ray equipment, significantly increasing worldwide CT imaging availability.

Awards Won:

King Abdulaziz &amp

his Companions Foundation for Giftedness and Creativity: On-line Mawhiba Universal Enrichment Program

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